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Etiology of diarrhoea

Vernal C. Norine
University of Nebraska Medical Center

V.C. Norine

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Definition: (23)(33)

Diarrhoea is a sympton usually defined as a pathological condition characterized by an excessively frequent and more or less liquid fecal discharge interfering with the comfort and well being of the individual.

Clinically, the term diarrhoea cannot be reduced to a strict definition, for most clinicians agree that the term diarrhoea is warrantable when the passages exceed two a day or four fairly loose evacuations in any single day, or when evacuations exceed a pint a day, not counting the evacuations of a retained feces at one time.

General Considerations: (16)(20)

Hyperperistalsis, the most important factor in diarrhoea calls for consideration, anatomically and physiologically, of the intestinal tract.

The intestinal tract consists of the small intestine, large intestine, rectum and the appendages of the digestive tract, directly opening into the intestine, the pancreatic duct and common bile duct through the ampul of vater.

The small intestine usually measures over twenty feet in length and is divided into three parts; the duodenum which constitutes the first eleven inches, distinctly marked off from the rest by its fixation and absence of a mesentery; the jejunum which comprises the upper two fifths and the ileum comprising the lower three fifths of the remainder. The jejunum and ileum pass imperceptibly into one another, the

division being artificially drawn between them.

The large intestine begins on the right side of the abdomen some two and one-half inches below the ileo-cecal junction and comprises the following parts; cecum, vermiform appendix, ascending colon, hepatic flexure descending colon, iliac and pelvic colon, rectum and the anal canal.

The length of the large intestine is equal to about one-fifth of the whole intestinal canal and usually measures about five feet. Its breadth is greatest at the cecum and except for a slight dilation at the rectum, it gradually decreases to the anus.

The small and large intestine have many things in common so that the structure, in general, can be discussed simultaneously.

The wall of the intestines is made up of four coats, named from without inwards, tunica serosa, tunica muscularis, tela submucosa, tunica mucosa. The serous coat is formed of the peritoneum, the tunica muscularis consists of unstriped muscle arranged in two layers, the outer layer of fibers run longitudinally and the inner layer of fibers run circularly; the submucosa is a loose but strong layer of areolar tissue connecting the muscular and mucous coats, on this layer depends the strength of the intestinal wall. It contains blood vessels and the glands of Brunner. The tunica mucosa is composed of three layers, one a layer of striated columna r epithelial cells, resting on a basement membrane, outside of this lies a layer of reticuform tissue containing a considerable number of lymph cells. This layer is limited towards the submucosa by an extremely thin sheet of unstriped muscle, called the

lamina muscularis mucosa. The mucous membrane is very vascular.

Throughout both the small and large intestine, the mucous membrane contains many tubular glands, glands of Lieberkuhn.

The extrinsic nerves belong to the sympathetic nervous system and are derived from the coeliac and mesenteric plexuses and are also connected with the right vagus nerve, anastomosing in the subserous tissue and muscular coat with the interlacing fibers and ganglion cells, termed the myenteric plexus of Auerback, and in the submucosa there is another plexus, the plexus of Meissner.

The vessels given off from the aorta on reaching the intestine bifurcate, giving a branch to each side of the gut, it pierces the muscular layer and forms a vascular plexus in the submucosa.

The large intestine maybe differentiated from the small intestine by the presence of three longitudinal bands, the taenia coli and by the fact that its walls are sacculated, and by the presence of numerous little peritoneal processes, known as appendices epiploicae, projecting from its serous coat.

Alvarez (20) has brought up the point that the digestive tract will work irresponsive of the extrinsic nervous supply, through the intrinsic nerve supply, which can be compared to the intrinsic nervous mechanism of the heart. The smooth muscle fibers are so constructed that Auerbach's plexus throughout the intestine takes care of a great lot of the movement and that digestion will be carried on experimentally even if the sympathetic and parasympathetics are servered. In other words the gastro-intestinal tract has the mechanism in itself so that peristalsis can be carried on. There is no doubt that the extrin-

sic nerve supply has much to do with peristalsis in both the normal and the pathological.

The function of Auerback's plexus is to serve for conduction of stimuli and coordination of movements. Another function of the plexus is probably to make the muscles respond to stimuli, coming from the underlying mucous membrane. These stimuli are collected by Meissner's plexus and transmitted to Auerback's plexus by connecting or association fibers. This is the reason for the hyperperistalsis in use of drugs as purges or by inflammation. Still another function of Auerback's plexus is to keep the muscle of the intestine from being to active, inhibitory as is the sympathetics.

There are several types of peristalic movements; food shoots through the first part of the esophagus largely because of the quick acting striated muscle, in the lower third of the esophagus . The action is slowed due to the presence of smooth muscle.

In the human stomach waves appear once every twenty seconds. The waves do not cross the pyloris but the duodenal cap tends to remain filled during the early stages of digestion, towards the close of gastric digestion there is normally some regurgitation of the duodenal contents into the stomach. The food once past the cap; then the food passes rapidly through the rest of the duodenum and jejunum. In the lower ileum, the progress is slowed particularly in the jejunum rhythmic movements are seen which serve to mix the food intimately with the digestive juices and to move it back and forth over the absorbing surface. These kneeding movements are brought about by local conditions of tension and have little to do with progression of food through the

bowel.

Most of the forwarding of the food is brought about by the "peristaltic rushes", these may arise in any part of the small bowel and may run either short or long distances. These rushes serve to move onward the material that has been segmented rythmically for a time at a point so absorption was allowed to take place.

Rush waves tend to be stopped by anti-peristaltic waves, otherwise the bowel would be rapidly emptied. This anti-peristalsis slows the intestinal contents above the ileo-cecal sphincter. This sphincter functions as to restrain material coming down above and to prevent regurgitation of colonic contents into the ileum. A gastro-colic reflex has been described and this is that when there has been stagnation near the ileo-cecal region, the contents are emptied into the colon upon taking food.

In the colon waves of contraction appear only at long intervals, reverse peristalsis is physiologic in the right half of the colon.

Stimulation in the intestine causes movement to go in both directions, hence the part having the greatest vagi nerve fibers will be the part affected in psychic changes, this part of the intestine is the jejunum. This theory will explain seasickness and other psychic changes.

Another factor (23) to be considered besides hyperperistalsis is the increase of mucous formation in mild cases of diarrhoea and the transudation of serous fluid in the more severe diarrheic conditions resulting from pathologically conditions.

Classification: (3)

In order to make a correct diagnosis and to institute proper treatment of a disease, the cause of the condition must be thoroughly investigated. In searching for a good clinical classification many facts were to be considered, for the anatomical and pathogical classifications were not errorless. The one chosen was based more or less on physiology which to me seems the most reasonable and important although the nomenclature is in error.

I. Intrinsic Colonic Stimulation.

A. Mechanical distention.
B. Chemical irritants.
C. Infection.
D. Tumors.

II. Extrinsic Colonic Stimulation.

A. Reflexes from other parts of the alimentary tract.
B. Reflexes from other than alimentary tract.

In the following discussion, this outline will be followed but several unimportant causes will be omitted, for diarrhoea would not be of any importance as a symptom as far as diagnosis is concerned.

I. Intrinsic colonic Stimulation.

A. Mechanical distention - (3)(33)(21)

Distention is a stimulant to the colonic nervous apparatus and if it is intact there is a desire to defecate.

Solid material may be introduced from without in the form of bulky food such as agar, bran, barium and green vegetables, such as cucumbers and green apples. These give rise to a diarrhoea which may be accompanied with very severe cramping pains.

Tumors such as lipomas, pedunculated carcinomas and the mass formed from intussuception may cause distention due to bulk and lead to diarrhoea.

Liquids may be ingested as such or introduced in the form of enemas, or may be generated in the lumen of the bowel from foods and they may also be excreted from the blood stream into the bowel. Liquids ingested very seldom cause mechanical distention.

In marasmus and with the use of magnesium salts, the blood gives up fluids and puts it into the lumen of the bowel. Another substance which is of a great therapeutic aid that takes fluid from the blood stream and puts it into the bowel is glucose when given intravenously.

Gases may lead to a diarrhoea but gases taken through the mouth never are sufficient to cause mechanical distention. Gases usually giving distention are developed in the lumen of alimentary tract from food. Gases formed from decomposed foods are acetic acid and hydrogen sulphide. These cause irritation and are responsible in part for diarrhoea in particular cases. Gas may be generated in the lumen of the bowel from diseased bowel walls. Both mechanical and irritating effect must be taken into consideration.

B. Chemical irritants cause many types of diarrhoea and those first considered will be drugs which when taken by mouth cause diarrhoea. Mercury (33) acts along the whole length of the intestine, cathartics such as rheum, aloin, oleum ricini, senna and sodium phosphate irritate the bowel. Phenolphthalein (3) acts on the lower part of the colon.

One case (6) of diarrhoea has been reported resulting from an idiosyncrasy for atropine. The diarrhoea was of the usual form except accompanied by cramping.

Foods that decompose either by action of abnormal fer-

mentative gastric juices or due to bacterial action have been a subject of discussion for a long period of time. Most of this work has been done in children. Not so many years ago, the mortality rate from diarrhoea was very great and yet today, diarrhoea is the most frequent complaint especially between the ages of two to three years of age.

The greatest study has therefore been done in children. Predisposing causes (5) have been mentioned, first, age: the second summer seems to be the most consistent. At this time the child goes from well balanced food of the mother's or modified milk to a diet unbalanced and unsuited to its digestive power, the child also creeps about and seeks to devour things encountered on the ground and floors. Second, is the season (5)(33) hot weather acts as a factor in lowering the resistance of the individual, overfeeding and warmth always favors bacterial growth. In the breast fed babies (33), the fact was brought out that in summer the mother drinks much more water accounting for the dilution of the milk. Other predisposing factors are conditions of the home, whether over crowded and underventilated or unclean. In large institutions if the diarrhoea is due to fermentation and putrefaction from bacterial action, nurses may be the carriers.

In these infantile diarrhoeas in which no cause can be found as to the extrinsic colonic causes, the explanation has been that bacteria causes changes in the carbohydrates and proteins so that irritating substances have been formed.

The fermentative diarrhoea is caused by saphrophytic bacteria which are normally found in the intestine, the stools are acidic in reaction. The bacteria according to some (13) causing

fermentative diarrhoea are B. dysentery, B. alkaligenes, B. typhosus, B. paratyphosus and the cholera group. Another group causing fermentative changes with marked prostration and profuse diarrhoea are B. aerogenes capsulatus, B. perfringens, B. Welchi, B. aminophilus.

Bacteria cause putrefaction of the proteins so that anto-intoxication takes place (13) and the stools are very frequent and watery, finally becoming chyle-like. The poisons formed from the bacterial action are ptomaines and aromatic amines. These types of diarrhoea have been coped with by using the percentage system (31) of fats, carbohydrates, proteins and minerals.

Coeliac disease has also been mentioned in which there may be diarrhoea alternating with constipation. This disease is not well understood but digestion and absorption of fats is very poor.

Hunger diarrhoea (13) although not definitely in this place of the classification is the result of inanition and as a sign of approaching death. These diarrhoeas do not always occur after absolute starvation but occasionally result from moderate under feeding.

Achylia gastrica has been mentioned as a predisposing cause of diarrhoea, the mechanism of action may be based on precipate emptying of the stomach (31) in which undue peristalsis follows in the small intestine and large intestine.

Several cases have been reported (22) in which either continuous and uncontrollable diarrhoea or attacks of diarrhoea have been encountered in diabetes mellitus, on gastric analysis there was an achlorhydria and upon administration of hydrochloric acid there was some relief.

Joslin taken from (22), states that diarrhoea in diabetic patients should have special attention and some of these cases are very sensitive to insulin.

Some general diseases (3) as heart disease, pneumonia and cirrhosis of the liver causing portal stasis with poor absorption from the intestine have been reported as a cause of diarrhoea.

Blood borne toxins occasionally result in gastric disturbance.

In advanced disease of the kidney (23) urea accumulates in the blood, part is excreted by the skin and part by the intestinal mucosa so therefore stimulated directly. Pneumonia (23) through increased carbon dioxide accumulation may act as source of irritation although as previously stated it may be due to disturbed circulation of the bowel. Mercury, arsenic alcohol, lead and antimony (33) have been described as causing hyperperistalis as has severe burns (3) through toxic action.

There are many deficiency diseases that give rise to the symptom, at either an early or late time. Pellegra has as one of its cardinal symptoms, (diarrhoea, dermatitis and death) diarrhoea. The nature of the deficiency is thought to be one of the vitamines. Hyperthyroidism (23) either toxic adenoma or exophthalmic goiter may give rise to diarrhoea. The mechanism may either be due to toxins (23) or to altered endocrine function with disturbance of the autonomic system. A case (32) of a woman aged 33 years came in to the hospital complaining of diarrhoea alternating with constipation, vomiting and headache. Physical examination and past history were essentially negative except for a small adenomatous mass in the right lobe. Laboratory examination of stools, chest, gastro-intestinal tract were negative. Thyroidectomy

was done and the patient gained twenty five pounds in six weeks and had no return of the diarrhoea.

A case of pancreatogenous fatty diarrhoea (4) was described and the "why" was difficult to explain. A review of the process of normal digestion and absorption of fat as described by Pfluger may help some. Fat must be brought into a water soluble form in order to be absorbed. Neutral fats are hydrolyzed by lipase and other lipolytic enzymes of the intestinal content into free fatty acid and glycerine. The free fatty acids are dissolved by bile and they combine with the alkali of the bile and intestinal content (soduim carbonate according to Pfluger) into soaps, which are absorbed. In the epithelial cells of the intestine, soaps are converted into neutral fat, glycerine is absorbed. Alkalies either go back into the blood stream or are secreted back into the intestine. Abnormal elimination of fats might be due to one of the following three causes - 1) Defective hydrolysis of fat due to insufficient production or action of lipase, 2) deficient saponification and 3) defective emulsification of fats.

Defective hydrolysis is evidenced by external and internal secretion imbalance in the pancreas but this view can't be accepted in those cases which show a normal or slightly impaired hydrolysis of the alimentary neutral fats. The fact that feces in pronounced cases contain only small amounts of soaps cannot be considered as supporting the view that saponification in the small intestine is poor. Fecal soaps are soluble in calcium and magnesium salts while soaps absorbed are mainly soluble sodium soaps. The third view is not true unless there be some liver pathology, so as yet, investigators are at a loss to explain the cause of diarrhoea.

C. Infections as an etiological factor are much more easily explained for the pathology can better be studied. This group is by far the most important.

The cocci will be considered first for there are few in this group. J. A. Borgen (8) has isolated a diplococcus which was taken from ulcers in the bowel upon proctoscopic examination. In seventy-one per cent of the cases examined, the diplococcus was obtained in pure culture. The organism is lancet shaped, gram positive and resembles quite closely the pneumococcus probably belonging to the streptococcus group. Distant foci of infection may have much to do with the cause of the ulcerative colitis. This can be proven to a fairly certain degree by using rabbits and injecting intravenously and finding the ulcer in the intestine on post-mortem examination.

The bacilli compose the largest group of causative consequence.

Typhoid, para-typhoid A and B probably at one time comprised the greatest offenders but since so much work has been done in preventive medicine, these diseases are rarer. The manner of the hyperperistalsis is by irritation from the presence of the ulcer invading the Peyer's patches of the small intestine. Typhoid fever (14) in the young causes more frequent stools but is not of a severe grade, stools are usually thin and fluid, and contain an excess of mucous.

Tuberculosis (21) of the intestine in the majority of instances are of secondary type, probably swallowed, with the ulcer forming in the intestine or by extension from the mesenteric glands through the tunics of the bowel. Pulmonary tuberculosis (7) may cause diarrhoea due to a toxin which is elaborated by the tubercle

bacillus. The diarrhoea is nevertheless of the chronic type and quite frequently seen now, since more cases of pulmonary tuberculosis are diagnosed today.

Infection by the Bacillus dysenteriae (17) is seen in several conditions. The disease is seen in breast-fed as well as those that are bottle-fed and occurs as an acute primary infection in children that were previously well and as a subacute infection without previous acute symptoms, also coincidental with childhood diseases and may be seen as a terminal condition in children suffering from mal-nutrition. The disease is not necessarily confinded to anyone locality. The mode of infection is a question but possibly is through water or milk, but nothing definite was found. The infection may be mild, moderate or severe.

The spirilum are usually not seen but syphilis (31) (treponema pallida) occasionally manifests itself both as congenital and also primary condition. In congenital, the lesions most frequently found are in the lower part of the ileum where syphilitic granulation tissue develops, ultimately breaking down ulcerating at right angles to the course of the intestine, healing gives rise to an annular constriction. In primary syphilis, the lesions have a predilection for the lower end of the colon and rectum, seen more often in women than in men. Diarrhoea in syphilitic cases quickly deplete the patient and are hard to control unless specific treatment is instigated. Coma spirilum (3) causing cholera is another organism seldom met with in this country.

Although protozoa are common causes of diarrhoea in the tropics, they must be thought of in cases of diarrhoea in any section of the universe.

The entomoeba histolytica (1) is thought to be the cause of aestival blood diarrhoea. Wide spread presence of the entomeba histolytica among even healthy suggests that they play an important role in the occurrence of intestinal diseases.

Examination was done on stools of two hundred twenty-five patients who had been admitted to the hospital. Fresh stools were necessary for examination otherwise the motility of the protozoa would be lost. Of the patients examined, at least once, forty-nine per cent were found to be infected with some protozoal organism. One case of fatal balantidiosis was reported who had previous contact with pigs, protozoalogical examination on the day of death revealed a great number of balantidium coli. In Leningrad, at least fifteen to twenty per cent of cases of acute aestival diarrhoea were cases of amoebic dysentery.

Trichomanos and chilomastix (3) are mentioned as possible protozoa causing diarrhoea.

Fungi produce hyperperistalsis by irritation of nerve endings resulting from the ulcers formed. Blastomycosis (28) causes the growth of small abscesses which break down into ulcers later. Some state that the lesion resembles tuberculosis quite closely.

A group of fungi called "fungi Imperfecti" (15) have been described, the term loosely includes oospora and monila. Experimentally, rabbits on partaking the organism, develope diarrhoea. The conclusions are still not convincing.

Worms common to man in the intestinal tract causing diarrhoea are quite a frequent thing, although flukes outside of the tract cause diarrhoea, from vascular stasis of the intestine.

Fasciolopsis buski (18) is the most common pathogenic fluke to man, There is wide distribution, being found in Natal, India, Assom Siam, Cochin, China. The manifestation s are diarrhoea and edema. If a considerable number of flukes are present the adult parasite lives in the duodenum, eggs after being passed in the stool require from two to four weeks in water before the miracidia begin to hatch. These mircidia penetrate snails and there developes into sporocysts, from these, two generations of radial form, after leaving the snail they swim to a favorable spot, usually a plant, the water chestnup, which is usually eaten raw. This plant shows the presence of a great number of encysted rediae.

Another fluke (26); the clonorchis sinensis or chinese liver fluke has been spoken about. This fluke doesn't have the gastro intestinal tract as a habitat but lives in the biliary tracts of man, dog, pig and cat. In China and Japan, the frequent stools in this disease are the result of the liver damage with gastro intestinal blood stasis, therefore this diarrhoea is usually accompanied with blood.

Ascaris lumbricoides (25), a common intestinal round-worm, was first described by Linnaeus in 1758. The parasite is common in the small intestine of man, especially children in all parts of the world although more common in the warm moist climates. The female parasite hatches eggs which pass through the feces, then the intermediary host becomes infested and the larva grow in the lungs and finally reach the intestine by way of the esophagus so a cycle from man to animal or vice versa is begun.

Children get the worm from infested floors.

Strongyloidosis (9), a disease characterized by diarrheol attacks due to an inflammatory irritation of the colon as a result of infestation by the larvae of Strongyloides intestinalis. The female parasite deposits the ova in the epithelium of the crupts of the intestine especially in the colon and rectum. The number of ova in each infested crypt varies from one to five. After embryonal formation, they pass through the epithelium or lumen of the crupts and travel down the intestinal tract with the fecal material, in the feces they change to larvae or develope into sexually mature worms. Reinfection can either take place through the skin the the region of the Anus or by invasion of the gastro intestinal tract. It is thought that the mother worms die. Persistence of the disease might be accounted for by the larvae becoming blood borne.

D. Tumor toxins are no doubt a factor in some instances but ingeneral the ulcer or mechanical effects of the tumors are the cause of the diarrhoea. In instances hwere the tumor (3) is outside of the gastro-intestinal tract. Tumor toxins may cause a reflex nervous influence on the mechanics of the gastro-intestinal tract resulting in diarrhoea.

II. Extrinsic Colonic Stimulation.

A. Reflexes from other parts of the gastro-intestinal tract.

In following the outline of classification (3), there again is some mistake in calling the sinuses, middle ear; bronchi and nasal passages parts of the gastro-intestinal but for the practical side it is all right. These causes will be discussed under "B". Reflexes from other than alimentary tract". In reading, the only

reason supplanted for increased peristalsis arising from other parts of the gastro-intestinal tract are nervous inflexes through the extrinsic nerve supply.

B. Reflexes from other than the Alimentary tract - This type of reflex is no doubt thru the extrinsic nerves also.

In children, upper respiratory infections as a cause of diarrhoea have been put on a sound basis as an etiological factor. Acute Mastoiditis (24) and acute sinusitis (24) have a direct relationship which exists in cholera infantum. First knowledge was gained through necropsies. In a number of instances of deaths from what seemed to be "cholera infantum", the only pathological findings of importance were the connection between acute sinusitis or acute mastoiditis. In most cases the infection is usually well hidden but prompt recovery was established upon proper drainage from the site of the infection.

Pediatricians today believe that throat and acute Otitis media (3) have the symptom "diarrhoea" more frequently than the more chronic upper respiratory infections.

Alvarez (20) believes that psychic changes cause hyperperistalsis due to the fact that stimulation of the jejunum takes place through the vagus; jejunum having the greatest number of vagi fibers. Diarrhoeas from other psychic changes such as seasickness, horrifying visual phenomena, disgusting odors and sickening tastes may be explained on Alvarez's Theory.

Psychoginic factors in ulcerative colitis and bloody diarrhoea (2) brings out the fact that a state of emotion is often accompanied by hypermotility and spasticity of the colon; most likely also by hypersecretion and vasamotor disturbances. On the

basis of numerous histories which show a relationship between mental and physical symptoms and inasmuch as nervous and colonic disturbances agree, case reports reveal how serious the physical condition can become in the following instances; 1) if emotional conflict is deep seated or chronic; 2) if there is a specific organism; 3) if the individual is predisposed in some way by early childhood training, heredity or nervous makeup to colon afflictions. The outstanding trait was found to be, besides fearfullness, emotional immaturity. It goes without saying that diarrhoea is an infantile response to fear. Organization of the infant is presumably such that fear is often expressed by excitation of the colon and thus patterns may be laid down and not outgrown. Aside from physical symptoms, colitis patients revealed definite childish elements in their makeup. Story as summed up in phrases, "They feel cramped", and "They haven't got the guts."

Thermic, atmospheric, allergic, endocrine and chemical influences (3) have been covered as predisposing causes elsewhere in this paper.

Peripheral neuritis and herpes zoster, and tabes might be mentioned but tabes causes the loss of sphincter control and this type of condition does not hold to some of the definitions given by some men.

Pathological conditions in the pelvis (3) have been brought up in literature but the significance does not seem to be very great as a causative factor.

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